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PHYSICS.—*A mechanical differential telethermograph and some of its applications.* LYMAN J. BRIGGS, Bureau of Plant Industry.

This instrument consists essentially of two independent Bourdon spring systems, each hollow spring communicating with a copper bulb by means of a copper capillary. Each system is completely filled under pressure with a liquid having a high thermal expansion coefficient. These two systems are mounted as shown in the illustration in such a manner that the free ends of the springs move in the same plane and in opposite directions when the two systems undergo the same change in temperature. The free ends of the two Bourdon springs are connected in the plane of movement by a double link, the two members of which are approximately parallel and normal respectively to the paths traversed by the ends of the springs. The normal link is connected at its approximate center to a second link which communicates with the pen mechanism.

When the two systems undergo a simultaneous change in temperature, the free ends of the springs, in expanding or contracting, rotate about the center of the connecting link without producing any translation of this point. No change occurs, therefore, in the position of the recording pen on the drum. When, however, a differential change in the temperature of the two systems occurs, a greater movement is produced in the free end of one Bourdon spring than in the other, and a corresponding movement of the pen-arm takes place. The instrument is thus designed to record differences in the temperature of the two systems, independent of the absolute temperature.

While the Bourdon springs necessarily expand in response to an increase in their own temperature independently of that of

the bulbs, such changes do not affect the reading of the instrument, providing the springs do not differ substantially in temperature at any time during this change. To secure this equality in temperature of the two springs as nearly as possible, the instrument is provided with a metal cover blackened inside, and the interior is given an open construction. The two copper capillaries can also be kept at the same temperature for the greater part of their length. The differential temperature

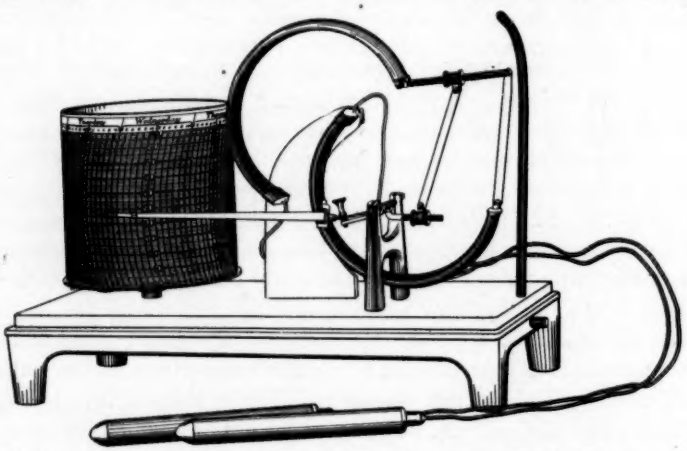

Fig. 1. A mechanical differential telethermograph. Capillary tubes much longer than those shown in the illustration may be used.

recorded is, therefore, substantially that represented by the difference in temperature of the two bulbs.

APPLICATIONS

Two applications of this instrument have been made during the past year in connection with investigations in bio-physics.

Recording the depression in temperature of the wet-bulb thermometer. One use of the instrument consists in recording changes in the depression in temperature of the wet-bulb thermometer. For this purpose the apparatus is placed in a ventilated instrument shelter. One bulb is covered with muslin and kept con-

tinually moistened by allowing water to drop upon it very slowly from a reservoir, while the other bulb assumes the temperature of the shelter. In this way a continuous graph is obtained of the depression in temperature produced by the wet covering, independently of changes in the air temperature. By using this record in connection with a simultaneous record obtained with an air thermograph, the humidity at any time can be calculated from standard psychrometric tables.

Recording changes in intensity of solar and sky radiation. If one bulb of the instrument is blackened and exposed in a glass jacket to radiation from the sun and sky, while the other bulb is kept at air temperature, the differential temperature of the two bulbs due to the radiation received is recorded. The instrument in this form gives a continuous record of changes in the intensity of the radiant energy received, altho the interpretation of this record in absolute units is of course dependent upon calibration with an absolute instrument. The types of sunshine recorders ordinarily employed give no indication of the magnitude of the changes in the radiant energy, but indicate simply whether the radiation exceeds a certain intensity.

The development of the instrument with a view to providing a continuous quantitative record of the intensity of the radiation received at the earth's surface is now in progress.

PHYSICS.—*Media of high refraction for refractive index determinations with the microscope; also a set of permanent standard media of lower refraction.* H. E. MERWIN, Geophysical Laboratory. Communicated by Arthur L. Day.

A number of experimental studies have been carried on for the purpose of extending the conditions under which determinations of refractive index by means of the microscope can be made. Such determinations require immersion media of standard refractive index. Various immersion liquids have been in use for the determination of refractive indices over the interval 1.33 to 1.80; mixtures of amorphous sulfur and selenium have been found useful over the range (for sodium light) 2.1 to 2.4. The immersion media to be described have been devised to fill the gap 1.80

to 2.10, and to extend the series beyond 2.4_{Na}, or in special cases, particularly when a refractometer is not at hand for standardizing the liquids, take the place of media hitherto used. For the latter purpose solids have been found which may be mixed in given proportions by weight to produce permanent standard media. These are either vitreous (more or less rigid) or liquid (fluid).

Altho differences in refractive index as small as 0.001 can be detected under the microscope by either the method of oblique, or of central illumination, it is seldom that in determinative mineralogical work results closer than 0.01 are of practical use owing to the complex character of most minerals. For this reason many details concerning the preparation and use of these

TABLE 1

CHI_3	SnI_4	AsI_3	SbI_3	S	n_{Na} at 20°
			12		1.764
	25				1.783
	25		12		1.806
	30			6	1.820
	27		7		1.826
40	27	16			1.842
	31	14	8	10	1.853
35	31	16	8	10	1.868

media are not included here but may be found in the complete record of the work when published.

Liquids, n = 1.74 to 1.87. In 100 parts of methylene iodide at 20° the number of parts of the various substances indicated in the table (1) can be dissolved, forming saturated solutions having the permanent standard refractive indices specified.

When ready for use, the liquids can be mixed by means of a dropper to give intermediate refractions. Commercial iodoform (CHI_3) powder is not suitable, but crystals from a solution of the powder in ether may be used; or the crystallized product may be bought. A fragment of tin in the liquids containing SnI_4 will prevent discoloration.

Liquids, n = 1.74 to 2.28. Near its boiling point methylene

iodide slowly dissolves precipitated arsenic trisulphide, forming an orange-colored liquid. After some days crystals separate, but while fresh—or after the heating of an old preparation which is not discolored—the solution can be used for accurately matching the refractive index of a substance, and then standardized by means of a goniometer[1] or a spectrometer and prism.

Resin-like substances, n = 1.68 to 2.10. Piperine, one of the least expensive of the alkaloids, can be obtained in very pure, straw-colored crystals. When melted it dissolves the tri-iodides of arsenic and antimony very freely. The solutions are fluid at slightly above 100°, and when cold are resin-like. The red color of the iodides is present in the solution. The color, however, is of such a character that determinations of refractive index made in the solutions in white light are almost as accurate as those made in sodium light. If less than 7 per cent of the iodides is present this solution should be examined thru a film of a 7 per cent solution. A solution containing 3 parts of antimony iodide to 1 part of arsenic iodide with varying proportions of piperine is easier to manipulate than one containing either iodide alone. The diagram, figure 1, gives the necessary data concerning composition and refractive index for sodium light. In preparing, the constituents, in powder of about 1 mm. grain, should be weighed out, and then fused *over*—not *in*—a low flame. Three-inch test tubes are suitable. Stirring with a glass rod is essential. A little of this material is placed on a glass slip with some of the powder to be examined, it is then warmed and pressed thin under a cover-glass. For use with the more highly refracting materials the powder must be very fine to permit a very thin film to be made. An artificial light is advantageous for observing the deeply colored films. The iodides should be examined under the microscope for mechanical impurities.

Mixtures of amorphous sulfur and arsenic trisulfide, n = 2.1 to 2.6. These mixtures are much lighter colored than corresponding ones of sulfur and selenium, but they are less easily standardized and manipulated. They should be used only in cases requiring greater transparency than the sulfur-selenium mixtures. They

[1] See Am. Jl. Sci. **34**: 46. 1912.

must be standardized by means of a prism which is ground or moulded. About equal parts of dried precipitated As_2S_3 and

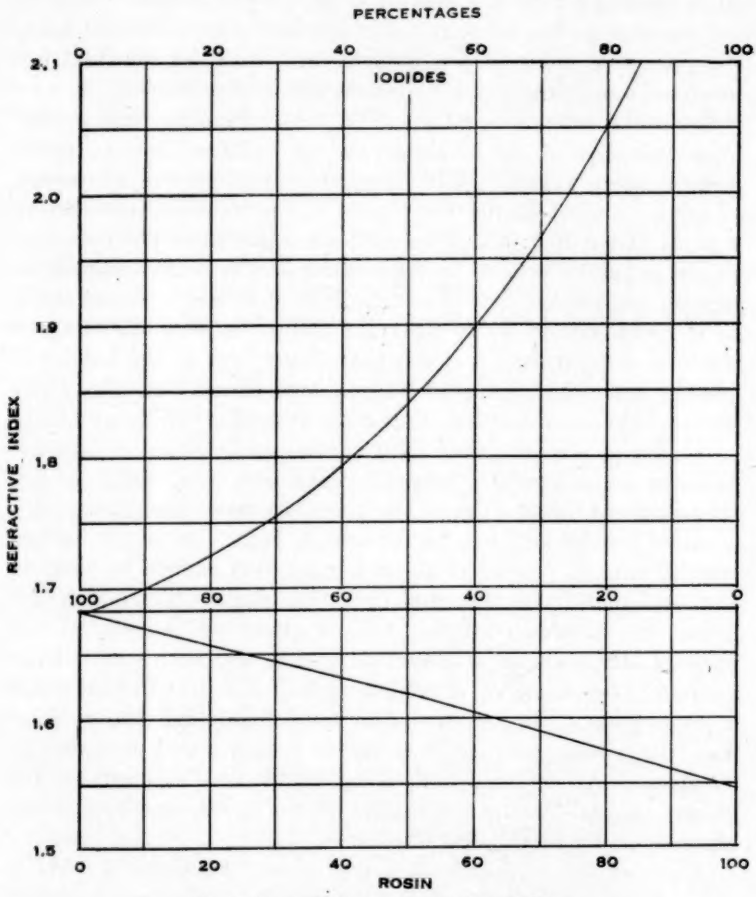

Fig. 1. Composition and refractive index

flowers of sulfur are intimately mixed by grinding moist with alcohol. The mixture when dry is strongly heated in a test tube which is not more than one-third full. A part of the sulfur will

boil away. The mixture remaining can be powdered and heated with either sulfur or As_2S_3 to produce a mixture having the desired refractive index.

Permanent standard resinous media, n = 1.546 to 1.682. Any proportions of piperine and rosin form a homogeneous fusion which cools to a transparent, resinous mass. Figure 1 shows the refractive indices of various mixtures. On account of the strong dispersion of piperine the refractive indices of minerals apparently matched with those of mixtures rich in this constituent are 0.005 to 0.01 too low. To correct the error a screen made of a thin film of 7 per cent antimony iodide and 93 per cent piperine should be used over the eye-piece. Any amber-colored rosin in lumps is suitable.

TABLE 2

CAMPHOR	THYMOL	MIXTURE OF 2 PARTS THYMOL, 1 PART CAMPHOR	SALOL	MIXTURE OF 6 PARTS SALOL, 4 PARTS CAMPHOR	ALPHA-NAPTHYLAMINE	n
35	65					1.487
67	33					1.505
		100	0			1.505
		60	40			1.536
				100	0	1.536
				50	50	1.610
			23	77		1.610
			0	100		1.683

Permanent standard resinous media, n = 1.510 to 1.546. This series is prepared from rosin and camphor. Each per cent of camphor present lowers the refractive index 0.0007. Not more than 40 per cent of camphor may be present without causing crystallization. The rosin is weighed out and melted slowly, when it is partly cooled but not yet hard, the camphor (well crushed) is stirred in. Heat is then applied gently and stirring is continued till the camphor is dissolved. Camphor does not volatilize appreciably from the cold mixtures if they are kept in stoppered containers.

Permanent standard fluids, n = 1.487 to 1.683. Several organic solids have been found which form eutectic mixtures melting much below ordinary temperatures. By plotting on cross-section

paper and connecting by straight lines each pair of points in table 2 the composition and refractive index of a complete series of fluids will be represented. Errors in n will not exceed $\pm$ 0.003 if fairly pure crystalline substances are used. Some of the fluids having n between 1.61 and 1.683 may crystallize after standing, but slight warming will restore their fluidity. Other materials under investigation give permanent fluids over much of this range. Where three constituents are specified in the table two of them in fixed proportions are used to form one variable constituent.

ELECTROCHEMISTRY.—*The silver voltameter. III.* E. B. ROSA, G. W. VINAL and A. S. MCDANIEL. To appear in the Bulletin of the Bureau of Standards.

The second series of quantitative experiments began in December, 1909, after several months spent in the qualitative work described in Part II. As a result of the preceding work the authors had discarded the filter paper voltameter as an instrument of precision and turned their attention to the problems related to the porous cup form and the purification and testing of the electrolyte. The apparatus and methods employed were similar to those previously described.

During this period of the work the small porous cup voltameter was found to be the most convenient and reliable form to use as a standard. With the purest salt available the deposits were adherent and white, always non-striated, and crystalline as seen under the microscope. As a test of the reproducibility of this small porous cup form, fifty-four deposits made in pairs (except two sets of three each) in which the electrolyte and other conditions were as nearly identical as possible in the two cups of each pair were tabulated. The average deviation of each value from the mean of each group (of 2 or 3 cups) was found to be 1 part in 100,000. That is, when the variations in the electrolyte and the measurement of current and time are eliminated so that it is simply a question of how nearly two similar voltameters agree with one another and the variations are produced by loss of silver in washing the deposit, fluctuation in moisture or impurity in the deposit and the errors in weighing the cups the average

deviation of individual values from the mean of 2 or 3 cups is only 0.001 per cent.

Comparison of the large porous cup voltameter with the smaller size showed consistently a heavier deposit in the former by about 5 parts in 100,000 and the siphon form which required a very large volume of electrolyte gave a still greater excess. It was at length discovered that this excess of deposit in the larger sizes was roughly proportional to the volume of the electrolyte and the authors have called this the "volume effect." It seemed probable that this was due to traces of impurity which had not been eliminated from the electrolyte and led to an extended investigation of the purifying and testing of silver nitrate. As a result of this work, electrolyte was prepared which satisfied all the criteria for purity and brought the large sizes of voltameters into agreement with the small porous cup voltameter, thus justifying its previous use as a standard form. The effect of slight contamination of the electrolyte in this small size must have been almost negligible as the results obtained with it have been amply justified by the subsequent work. As the experiments progressed the "volume effect" was found to be a very useful indication of the purity of the electrolyte, revealing the presence of impurities too small in amount to visibly affect the crystalline structure of the silver deposit. It is not claimed that this phenomenon of heavier deposits in large voltameters is a new discovery, for it was observed in the work of Lord Rayleigh nearly thirty years ago and has been ascribed to various causes, but the authors do believe that its significance has not been appreciated before, nor the correct explanation for it given.

Using the mean of 44 of the most reliable determinations made in the small porous cup form of voltameter during the period December, 1909, to April, 1910, the authors have obtained as the value for the Weston Normal Cell at 20°C. on the present basis:

$$1.01827_5 \text{ volts.}$$

This is very close to the value recorded in the first series of measurements and is probably more reliable.

Several determinations were made in which two voltameters were maintained at 50°C. by external heating coils during the

passage of the current, for comparison with two similar voltameters at room temperature (about 20°C.). The results indicate that there is no temperature coefficient as Kohlrausch and Weber also have shown in a different way. It is believed that the reasons other observers have found increased deposits in voltameters at higher temperatures is because the chemical activity of impurities in their electrolyte would naturally increase with the rise in temperature.

Two gold dishes similar in design to the smaller platinum dishes previously used were purchased for comparison. By tabulating the differences in deposit between the gold and platinum cathodes in each case where no other differences in the voltameter existed it was found as a result of twenty-nine comparisons that the deposits in the gold dishes were lighter by 1.4 parts in 100,000 which may be regarded as indicating the substantial agreement of the two materials.

Some further work was done with the Poggendorff form but the results were not encouraging and hence attention was directed chiefly to the forms that had proved more reliable and the purification and testing of the electrolyte in anticipation of the coöperative work with the English, French and German National Laboratories which began in Washington April 1, 1910.

The most difficult problems connected with the preparation of silver nitrate for use in the voltameter are concerned with the exclusion or removal of reducing impurities and colloidal silver on the one hand and of uncombined acid and base on the other. The tests that have been developed for determining the acidity of the solution are for the purpose of determining the uncombined acid or base rather than the absolute hydrogen ion concentration.

The usual methods of testing the neutrality of salts do not apply to silver nitrate. Thus, toward litmus a silver nitrate solution will react alkaline even after the addition of 1 part in 100,000 of nitric acid and a similar solution will react acid toward methyl orange after the addition of alkali provided the silver is not completely precipitated. Other indicators also were tried. If the silver be precipitated from the silver nitrate solution by neutral KCl solution and the AgCl precipitate filtered off on asbestos

the filtrate will show a neutral reaction toward the various indicators if the original $AgNO_3$ contained no uncombined acid or base. By using iod-eosine as an indicator so little as 1 part in 1,000,000 of nitric acid (or alkali) added to the original $AgNO_3$ can be detected in the filtrate by titration with $\frac{N}{1000}$ HNO_3 or NaOH. The results have been expressed in terms of parts per million of the nitric acid.

For the detection of the more resistant forms of reducing impurities (principally cellulose hydrates from filter paper) and colloidal silver a titration test with $\frac{N}{1000}$ $KMnO_4$ solution has proved very valuable. The slightly acidified crystals of silver nitrate are fused as will be described for purifying the salt and dissolved in water to form a 66 per cent solution. Ten cubic centimeters of this solution is acidified by adding 1 cc. of concentrated nitric acid (free from nitrous acid) and the $\frac{N}{1000}$ potassium permanganate solution added in 0.5 cc. portions until the pink color persists for five minutes or more. The number of cubic centimeters thus required the authors have called the "permanganate number" of the silver nitrate. In test cases this has been found to be proportional to the amounts of oxycelluloses previously added to the silver nitrate and very minute traces can thus readily be detected. It is not claimed that the organic material is necessarily oxidized completely but nevertheless the method is much more sensitive than any method of direct combustion would prove under the circumstances as well as being more expeditious. By titrating these concentrated solutions of silver nitrate less than 0.001 per cent of colloidal silver may be detected, a result that is of particular value in showing when over fusion of the salt has occurred in its preparation.

The water used was twice distilled in block tin and kept in bottles of especially prepared resistant glass. Samples of it were frequently tested for its conductivity and alkalinity. These were, on the average, about 1.3×10^{-6} reciprocal ohms and 0.6 parts in 1,000,000 respectively. The water in the stills was boiled by steam under pressure thereby avoiding the possibility of contamination by CO_2 which may greatly increase the deposit in the voltameter.

For purifying the silver nitrate for use in the voltameter it is convenient to start with the best c. p. salt obtainable from the manufacturing chemists. If this salt is repeatedly recrystallized from neutral solution the resulting product shows a tendency to become basic which under certain conditions gives rise to the volume effect in the voltameter. To avoid this condition it is necessary that the last mother liquor should be acid to the extent of from 0.1 to 1 per cent of the water present depending on the efficiency of the draining. In the present work a centrifuge has been employed and the crystallization carried out in porcelain, quartz and platinum vessels without any significant differences in the final product. It is best that the preliminary recrystallizations should be made from strongly acid solutions as this increases the yield of crystals owing to the less solubility of the $AgNO_3$ and decreases the number of crystallizations required to satisfy the permanganate test.

Salt yielding the same result in the voltameter has also been prepared by recrystallization from strongly acid solution and subsequent fusion. The fusion appears to break up the more resistant impurities contained and in some cases these come to the surface and may be readily removed by washing the surface of the fused cake as suggested by Mr. F. E. Smith. The fusion also furnishes a ready means of controlling the amount of acid in the final product, but especial precautions must be taken. Whether the silver nitrate is decomposed by heat when fused seems to depend less on the temperature than upon the amount of acid retained by the melted salt. As soon as the last trace of acid is expelled the salt begins to decompose into silver oxide and colloidal metallic silver as shown by the tests with iod-eosine and potassium permanganate respectively. By removing the salt from the furnace as soon as the last trace of solid material has melted it is found that a small amount of acid (1 or 2 parts in 100,000 of the solid salt) is retained and that this is sufficient to prevent decomposition, and in a 10 per cent solution is negligible in the voltameter.

Salt prepared in this way which is *satisfactory* for the voltameter is invariably a beautiful pearl white and never darkened as

noted by some earlier observers. The reasons why the salt recrystallized and fused according to the well known researches of Richards and Forbes (although well suited for their purposes of atomic weight determinations) is not suitable for use in the voltameter can only be given adequately in the complete paper to be published in Bulletin of the Bureau of Standards. It must suffice here to say that the authors have carefully followed their procedure and found the product unsuited for the voltameter, first because of the slight decomposition resulting from the prolonged fusion, and second because of the basicity formed from the repeated recrystallizations from neutral solutions.

In the fourth and last paper of this series the results subsequent to the work of the International Technical Committee will be given. These include experiments to determine the value of the Weston Normal Cell made with the highest precision and a discussion of the action of acid and base in the voltameter.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 712th meeting was held on October 12, 1912. In opening the meeting President Rosa remarked upon the present limitations of the field of the Society's activities, but stated that it had had a long and honorable career.

Mr. L. A. FISCHER of the Bureau of Standards addressed the Society on *Some types of false weights and measures found in the United States*, in which it was pointed out that Congress has never adopted any of the standards now in customary use, altho it is the common impression that the yard, pound, gallon, and bushel are fixed by legislation instead of being fixed by custom, which is true. Due to the fact that we have no national legislation, the states have been compelled to enact legislation entirely independent of one another, and often laws of neighboring states have conflicted. As little or no attempt, however, was made to enforce them until recently, their diversity was of no importance.

A few years after the establishment of the Bureau of Standards or in 1904, invitations were sent to the governors of the states to send delegates to a conference to be held in Washington the following year for the purpose of securing uniform laws and regulations for weights and measures. Only eight states and the District of Columbia sent delegates, but so much interest was manifested by the delegates who attended, as well as by the authorities in those states which, for one reason or another, were unable to send representatives, that it was decided to hold subsequent conferences each year. Altogether seven conferences have been held, and much work of a constructive nature has been accomplished. A model law was drafted, and this law has been adopted with modifications to suit particular states, by thirteen states. In order to bring home to the authorities in the states that failed to become interested in the movement for better conditions, and also for the purpose of assisting the weights and measures officials in the states that were active, the Bureau made an investigation of the conditions of the weights and measures in general use thruout the country, as well as to investigate the manner of their use. Every state in the Union was visited, and inspections were made in 184 cities or towns ranging in size from New York City, with a population of 4,500,000, to Carson City, Nevada, with a population of 2200. A number of stores using weights and measures were visited in each town or city and the condition of the scales, weights and measures was noted.

Something over 30,000 scales, weights and measures were tested, and about 45 per cent of the scales were found to be 3 per cent or more in error, mostly favoring the dealer.

A little less than 4000 prints of butter were also weighed, and an average shortage of 0.05 ounce per pound or 3.25 per cent was found, taking the estimates of the Bureau of Standards as to the consumption of butter per capita, and assuming that 30 per cent of the butter is sold in the form of prints, and is retailed at 33 cents per pound, it is found that there is a loss to the consumers of the country of $8,228,000 from this one item, and that this shortage is not accidental is shown by the fact that prints of the same brand of butter sold in two cities, one of which had an ordinance requiring the net weight to be marked on the outside of the print, while the other had no such requirement, were full one-pound in the first case while consistently short in the second.

The results of the investigations were communicated to the state officials and to individuals interested in weights and measures reform in the states, and contributed very largely to the passage of the excellent laws recently adopted by the states.

The activity of the states has brought out the fact that some national legislation is necessary, in order to unify the standards and methods, and bills to effect this are now before Congress.

The 713th meeting of the Society was held on October 26, 1912, Vice-President Fischer presiding. Two papers were read.

The 1912 excursion of the American Geographical Society: Mr. W. J. HUMPHREYS, of the U. S. Weather Bureau.

This excursion, trans-continental in scope, was eminently successful, and was in celebration of the sixtieth anniversary of the founding of the American Geographical Society and of the completion of its new home. Prof. W. M. Davis had charge of the arrangements of the trip, and of the personnel which consisted principally of distinguished persons from thirteen different European countries, more than half of whom were men the most eminent in their branches of work.

The special train on which the party traveled and its equipment were mentioned, and the route of travel and points of interest visited were briefly outlined and illustrated by a number of interesting lantern slides. The results of the trip were briefly summarized, among which may be mentioned the very favorable impression that the visitors received of America.

At the conclusion of Dr. Humphrey's paper the Secretary was formally directed to communicate to the American Geographical Society this Society's deep appreciation and thanks for the inception and successful execution of this memorable excursion, which must be productive of great and lasting good, not only thru its benefit to geography but also and especially by reason of the kindly personal relations thus established between learned and influential Europeans and Americans.

Some results of the new method of gravity reduction: WILLIAM BOWIE, of the Coast and Geodetic Survey. This Journal **2**: 499. 1912.

The 714th meeting was held on November 9, 1912. The following papers were read:

Media of high refraction for use with the microscope: H. E. MERWIN, of the Geophysical Laboratory. The chief purpose of the results described was to make possible the identification of minerals. The microscope can be used for determination of refractive index of all solutions that are not opaque. A refractive index chart was exhibited covering a range of 1.5 to 3.0, and the physical properties of the mixture used to get this range were described. This range of media can be made standard by weighing out the materials. The absorption and heat effects were spoken of, and the variations of some of the media were described.

The last meeting of the International Geodetic Conference at Hamburg: O. H. TITTMANN, of the Coast and Geodetic Survey. A brief account was given of the origin and growth of what is now the International Geodetic Association, and of its present organization and its work, this being followed by a brief outline of what the Hamburg meeting dealt with. The mode of government of the State of Hamburg was mentioned. About 50 delegates attended the conference from the 20 different countries represented. Much interest was taken in the reports on the variation of latitude work, and the next most important question was triangulation, of which the United States has generally reported the most work done. Isostasy was not much discussed. The social functions and points of interest visited were spoken of.

Under *Informal communications* Mr. Tittmann spoke of an automobile without springs, invented by Josef Hofmann, the pianist, and Mr. Bowie called attention to the completion of the marking of the boundary between Alaska and Canada north of the Yukon River, under the direction of Mr. Tittmann as commissioner on the part of the United States.

Before closing the meeting the chair announced the death of Dr. Robert Fletcher a past president of the Society.

The 715th meeting, held on November 23, 1912, was devoted to a general discussion of *The application of the microscope to physical problems*, the opening paper being given by Mr. F. E. WRIGHT.

In introducing the subject the speaker grouped the uses of the microscope under three principal heads, (1) Qualitative, as a magnifying glass, a seeing instrument; (2) as a measuring device, and (3) as an optical instrument, such as for measuring the optical properties of minerals. Types of microscopes were exhibited and their construction and manipulation described, illustrating the above mentioned uses of microscopes. A number of accessories were also spoken of which are designed to facilitate and extend the use of the microscope, especially as a measuring and optical instrument. In the discussion which followed:

Mr. BRIGGS spoke of his experience with the ultra-violet microscope, pointing out its advantages and disadvantages, and the methods employed to overcome the disadvantages, such as finding the object to be seen after it is on the stage, in which resort was had to the use of a

fluorescent screen, against which it was difficult to focus the microscope. The focusing is assisted by the use of monochromatic blue light.

Messrs. ROSA and VINAL mentioned the use of the microscope in connection with the determination of the ampere with the silver voltameter, particularly with reference to the method of growth of silver crystals and the effect on their appearance when impurities are present.

Mr. BURGESS described a micropyrometer which is convenient for measuring melting points of microscopic samples.

Historical aspects and the present status of the microscope were discussed by Messrs. WEAD, FENNER, MERWIN, NUTTING, HUMPHREYS and TILLYER. The last emphasizing the use of the blue line of the mercury lamp as illuminator and suggesting an improved form of projection eye-piece.

The 716th meeting was held on December 7, 1912. Two papers were read.

A consistent theory of the origin of the earth's magnetic field: L. A. BAUER, of the Carnegie Institution of Washington. See this Journal **3**: 1. 1913.

The earth inductor as an inclinometer: N. E. DORSEY, of the Carnegie Institution of Washington. The speaker gave an outline of the theory of the earth inductor with a continuously rotating coil and commutator. When thermal electromotive forces exist in the circuit the setting of the coil for a zero glavanometer deflection depends upon the speed; if however, the axis of rotation lies in the magnetic meridian this effect of variations in the speed is usually very small. A method for adjusting the brushes so that commutation shall take place when the plane of the coil is parallel to the inclination axis was described. When the brushes are thus set, and the inclination of the coil is so adjusted that the deflection of the galvanometer is independent, in both magnitude and direction, of the direction of rotation of the coil, provided the speed is the same in both cases, then the direction of the axis of the coil is exactly the direction that would be taken by a perfect dip needle placed with its pivots parallel to the inclination axis of the inductor. This is true for all azimuths, and is independent of the presence of thermal electromotive forces, provided that they are independent of the direction of rotation of the coil. For use at sea it is the mean value of the galvanometer deflection that must be independent of the direction of rotation.

The 42d annual (717 regular) meeting was held on December 21, 1912, Vice-President Burgess in the chair. The meeting was devoted to hearing the annual reports of the officers and to the election of officers for 1913, the following being chosen: President, C. G. ABBOT; Vice-presidents, L. A. FISCHER, W. S. EICHELBERGER, G. K. BURGESS, WILLIAM BOWIE; Treasurer, R. B. SOSMAN; Secretaries, W. J. HUMPHREYS and J. A. FLEMING. General Committee: N. E. DORSEY, L. J. BRIGGS, E. BUCKINGHAM, B. R. GREEN, E. G. FISCHER, R. A. HARRIS, F. A. WOLFF, D. L. HAZARD, R. L. FARIS.

R. L. FARIS, *Secretary.*

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 260th meeting, the first meeting for the fall, was held in the Cosmos Club, November 13, President Stanton in the chair. As an informal communication F. C. Schrader gave a brief account of an occurrence of bauxite in vertical fissure vein deposits thru limestone in the Bovard district of southern Nevada.

REGULAR PROGRAM

The work of the Conservation Congress: DAVID WHITE. Mr. White. was introduced as the new Chief Geologist of the Geological Survey, this being the first public announcement of his appointment to succeed Mr. Lindgren. He was received with hearty applause.

Reconnaissance in the Southern Wasatch Mountains: G. F. LOUGHLIN. The speaker presented certain structural and stratigraphic data collected during a reconnaissance survey of the ore deposits in the Wasatch Mountains from the Cottonwood district southward to the northern part of the Mt. Nebo ridge. The only Pre-Cambrian exposure south of the Cottonwood canyons is a band of Pre-Cambrian granite and schists extending for a mile along the base of the Santaquin ridge. This band is overlain unconformably by Cambrian quartzite about 800 feet thick. The Cambrian quartzite was found to include the occurrences mapped by the Fortieth Parallel Survey as the Ogden (Devonian) quartzite. The "Ogden" quartzite in the Cottonwood district proved to be a portion of the Cambrian, overthrust upon Madison (lower Mississippian) and older limestone, shale members in the overthrust quartzite carrying Cambrian fossils. Blackwelder's elimination of the Ogden quartzite in the northern Wasatch country is thus confirmed. The "Ogden" quartzite in the Cottonwood, as well as in the American Fork and Provo districts is overlain by the regular succession of Cambrian to Mississippian limestones—the same succession as is found above the Cambrian quartzite on the Santaquin ridge; but the thickness of the pre-Mississippian limestones is much less than in the Bear River ridge to the north or in the Tintic range to the southwest.

The stratigraphic section in the Cottonwood district is continuous from the Pre-Cambrian thru the Triassic; but southward the Weber (Pennsylvanian) have been bevelled off by an unconformity, since Eocene (Wasatch?) conglomerate, east of the Santaquin ridge, rests unconformably upon the upper Mississippian. West of Santaquin a veneer of the Eocene conglomerate rests upon pre-Mississippian limestone, and in the Sevier River Canyon, the same conglomerate rests upon Cambrian quartzite, thus showing that the whole Paleozoic section was bevelled by the unconformity. At all these localities the Eocene conglomerate is covered by patches of volcanic rocks, chiefly by a coarse andesitic breccia.

The principal structures noted are (1) westward overthrusts, including that already mentioned in the Cottonwood district and others at Santa-

quin and 7 miles still further south, Cambrian quartzite in every case overriding Mississippian limestone; (3) local doming and eastward reverse faulting around the intrusive Cottonwood granite stock; (3) fissuring and mineralization following the Cottonwood intrusion; (4) late normal (block) faulting which developed the Basin range. The latter is especially well exposed in the low western flanking ridges between Mt. Nebo and Santaquin, where the faults which lie along depressions can be proved by the discordant relations of the bed rock. The block faulting took place after the post-Eocene volcanic eruptions.

New data on the "Knox dolomite" in Tennessee and the "Ozarkian" in Missouri: E. O. ULRICH.

ROBERT ANDERSON, *Secretary.*

At the 261st meeting, held at the Cosmos Club on November 27, 1912, under informal communications, the following paper was presented:

An occurrence of petroleum near Cody, Wyoming: D. F. HEWETT. A petroleum spring was observed under unique conditions in the Akaroka Mountains, in northwestern Wyoming, during the summer of 1912. It is located on the west bank of Sweetwater Creek, 2½ miles north of its junction with the North Fork of Shoshone River, and is therefore about 26 miles due west of the town of Cody. The geology of the region is described by Hague in Folio No. 52, and the spring is situated in the basic andesite flows of Miocene age on the line (Lat. 40° 30′) between the Ishawooa and Crandall sheets.

The spring is unique in that it lies within 100 yards of several small sulfur deposits, situated on the east side of Sweetwater Creek. The sulfur deposits are identical in nature to those 12 miles north on Sunlight Creek, which were examined in 1911, and a report upon which appears in U. S. Geological Survey Bulletin No. 530, part O, 1911. The deposits embrace two classes of material: (1) sulfur which lies along the walls of open fractures in the lavas, and from which gases containing CO_2, CH_4 and H_2S are issuing, and (2) sulfur filling the interstices of gravels and surface débris along stream channels. The second class of material probably covers fracture zones. The oil spring is opposite an area 100 feet square into which prospect pits have been sunk showing sulfur cementing angular rock débris to a depth of 9 feet. Other smaller deposits of sulfur lie 700 feet farther up the creek.

Oil was first recognized issuing from the sands adjoining the creek. In the hole which was dug along the bank, water and oil slowly accumulated and several quarts of clear light oil were thus collected during the summer of 1911. During the writer's visit a pit was dug near the location of the old one which had been destroyed by freshets. The sand at this point is dark brown and has an asphaltic odor, but otherwise is such as would form bars along rapid mountain streams. In the short time at the writer's disposal only enough oil was collected to give assurance of its identification, but not enough for analysis.

Tho the superficial rocks of this region are igneous flows and breccias, these rocks overlie a great thickness of sedimentary rocks ranging in

age from Cambrian to Eocene, the Mesozoic section alone being approximately 14,000 feet thick 25 miles east. The sandstones of the Lower Cretaceous are oil-bearing near Cody, and the oils are light, relatively clear, and have a paraffin base. Evidence in nearby regions shows that the sedimentary rocks are much folded and that the lavas are cut by many intricate fractures, some of which, at least, are of recent origin. Sandstones outcrop on Shoshone River, 2½ miles south of the oil spring and about 400 feet lower, so that the lavas at the sulphur deposit are probably not over 500 feet thick.

The oil is probably to be traced to the sedimentary rocks, but its close relation to the sulfur deposits is unusual.

REGULAR PROGRAM

The Joplin lead and zinc deposits: C. E. SIEBENTHAL.

Secondary enrichment in silver: E. S. BASTIN. Microscopic studies of specimens of silver ore collected by E. S. Bastin and J. M. Hill from the mines near Lawson, Clear Creek County, Colorado, and near Caribou, in Boulder County, show that the ores owe their value largely to downward sulfide enrichment. The rich secondary sulfides are developed not only in cracks in the original ore, but as metasomatic replacements of galena and quartz. Sketches were exhibited illustrating such replacement. In the belief that such phenomena were of rather widespread occurrence, a specimen collected by W. H. Weed from the Big Seven mine, Neihart district, Montana, was polished and examined under the microscope. Replacements similar to those in the Colorado ores were well shown by the Montana specimen.

Certain mineralogical differences between the ores which exhibited enrichment in silver and other ores in the district which did not exhibit such replacement were pointed out. R. W. RICHARDS, *Secretary.*

PROGRAMS AND ANNOUNCEMENTS

THE WASHINGTON ACADEMY OF SCIENCES

January 30 at 8.15 p.m., Cosmos Club Assembly Hall. Illustrated lecture by Dr. ARTHUR L. DAY, *Some observations on the volcano Kilauea in action.*

THE BOTANICAL SOCIETY OF WASHINGTON

The 86th regular meeting of the Botanical Society of Washington will be held in the Assembly Hall of the Cosmos Club at 8 p.m., Tuesday, February 4, 1913.

SCIENTIFIC PROGRAM

Brief Notes and Reviews of Literature.

T. H. KEARNEY, *Indicator value of natural vegetation in the Tooele Valley.*

H. B. SHAW, *The control of seed production in beets.*

The program will be followed by a social hour, with refreshments.